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Discussing Patient Management Online: The Impact of Roles on Knowledge Construction for Students Interning at the Paediatric Ward

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Abstract. The objectives of this study are to explore the use of asynchronous discussion groups during medical students' clinical rotation in paediatrics. In particular, the impact of role assignment on the level of knowledge construction through social negotiation is studied. Case-based asynchronous discussion groups were introduced to enhance reflection and critical thinking on patient management and treatment, and to offer an exercise in evidence-based medical practice. Groups of approximately 4–5 students were asked to discuss 4 authentic cases during clinical rotation in paediatrics. 49 students interning at the paediatric ward participated in this study. With respect to role assignment, differences between groups (1) with a student or an instructor as moderator and (2) with or without a developer of alternatives for patient management were explored. A content analysis was performed to explore the different levels of social construction of knowledge. The results of multilevel logit analyses show a significant difference in knowledge construction through social negotiation between conditions with a student moderator and conditions where the instructor is moderating, but only when a developer of alternatives is involved. No significant difference was revealed between student-moderated and instructor-moderator groups without a developer of alternatives. It can be concluded that when both the moderator and developer role are assigned to students, their contributions are more likely to reflect a high level of knowledge construction.

Key words: asynchronous discussion groups, clinical rotation, computer-supported collaborative learning (CSCL), knowledge construction, medical students, paediatrics, reflection, roles

Introduction

Current educational practice in medical education shows a growing use of Information and Communication Technologies (ICT). The information component of ICT is essential: recent articles argue that "the full text of medical journals is becoming increasingly available electronically" (Wallace, 2001, p. 778) and the use of ICT to access medical information in general has important implications in medical education (Carney et al., 2004). But also the communication component of ICT has its importance for medical education, as "computer technologies can support a wide range of learning activities which engage students in a continuous collaborative process of building and reshaping understanding" (Greenhalgh, 2001, p. 40). The present study is primarily connected to this communication component and focuses on asynchronous online discussion groups as a rich environment for active learning in which learners actively build knowledge (Grabinger, 1996; Greenhalgh, 2001).

The advantages of the application of asynchronous discussion groups are fourfold. First, integrating ICT gives students the opportunity to get acquainted with essential technologies in order to keep up with the rapid growth in medical knowledge (Hagdrup et al., 1999). Second, asynchronous discussion groups are independent of time and location, increasing educational flexibility (Bernard and Lundgren-Cayrol, 2001). Third, asynchronous discussions provide students with extra time to reflect, think, and search for additional information before contributing to the discussion (Pena-Shaff and Nicholls, 2004; De Wever et al., 2006). Fourth, asynchronous discussion groups can be used to integrate clinical placements within the rest of the curriculum (Hagdrup et al., 1999; Stromso et al., 2004).

Building on these advantages, online discussion groups were introduced in the context of this study to stimulate reflection and critical thinking on patient management during a clinical rotation in paediatrics. The present study focuses more specifically on enhancing the process of active knowledge construction in the online discussion groups. The concept of collaborative learning and knowledge construction through social negotiation is borrowed from social constructivist theory. Constructivists see learning as a process of engaging in self-regulated, constructive, and reflective activities. Social constructivists furthermore consider individual learning as socially mediated. In this view, group settings can foster learning via questioning, criticism, and evaluation (Schrire, 2004). Therefore, it is argued that, in addition to individual cognitive processes, social processes play an important role in learning (Gunawardena et al., 1997; Schrire, 2004). Within collaborative learning, learners engage in shared knowledge building processes: knowledge is not just transferred, but co-constructed.

Research indicates that knowledge construction activities in online collaborative groups are influenced by the design and organisation of the learning environment (Lockhorst et al., 2002). It is important to thoroughly compose and structure asynchronous discussions, as structure is valuable to trigger meaningful discourse (Gilbert and Dabbagh, 2005; Weinberger et al., 2005). In this respect, this article focuses specifically on the impact of role assignment on knowledge construction through social negotiation.

The introduction of roles as a structuring tool

Scripts or structuring tools can specify, sequence, and assign collaborative learning activities in online learning environments (Kollar et al., 2003). Roles in particular can serve as a scripting tool to support the process of social negotiation in the discussions. They are seen as important factors in determining the quality of knowledge construction in a community (Aviv et al., 2003). Furthermore, research revealed that roles appear to affect the perceived level of group efficiency and elicit more task content statements (Strijbos et al., 2004). In this study, roles are introduced to structure the discussion process. Two different roles were assigned: a moderator and a developer of alternatives for patient management. The task of the moderator comprises monitoring the discussions, asking critical questions, and inquiring for the opinion of others. The role of developer consists of the exploration of alternative treatments for the ones already discussed (e.g. no medication, soothing medication only, other ways to administer medication, other forms/kinds of medication, etc.). This study focuses more specifically on the difference between instructor-moderated and student-moderated discussions on the one hand, and on discussions with versus without a developer of alternatives on the other hand.

As to the difference between student-guided versus instructor-guided discussions, the present study joins in with a number of studies in two related research fields, namely peer-guided instruction in higher education and peer tutoring in the context of problem-based learning. Concerning achievement of students, research in the former research field mostly showed no differences or rather conflicting results: sometimes better performances of student-guided groups are reported and sometimes instructor-guided groups perform better (Moust and Schmidt, 1994). Research in the latter field revealed either no differences or differences in favour of instructor-guided groups (Moust and Schmidt, 1994; Dolmans et al., 2002). Research furthermore shows that novice students are more dependent on their tutor's expertise (Schmidt et al., 1993). In addition, Dolmans et al. (2002) mention a shift from outcome-oriented studies to more process-oriented studies. They conclude that the content expertise of a tutor leads to more teacher-directed activities.

Non-content-experts tend to use their process-facilitation expertise more to direct the discussion groups, resulting in more student-initiated activities.

As to the difference between discussions with and without a developer of alternatives, it can be argued that the search for – and the development of – alternative solutions or heterogeneous answers is regarded as important, since one of the theoretical fundaments of between-peers learning environments is the socio-cognitive conflict (Joiron and Leclet, 2002). Researchers use the concept of socio-cognitive conflict to take account of how understanding may be shifted by interacting with other learners that have a rather different understanding of events. The basic idea is that when two contrasting world views are brought into contact, this is likely to stimulate some cognitive restructuring, learning, and improved understanding (Mercer, 1996). Solving socio-cognitive conflicts can increase the amount of explicit comparisons of information and engage the different interaction partners into joint knowledge construction through social negotiation. Furthermore, processes of reasoning and explaining are fruitful for collaborative learning (Joiron and Leclet, 2002).

Taking into account that our context involves advanced level medical students, that the role of moderator is to guide the discussions (and not to deliver subject matter), that our focus is on the process of constructing knowledge through social negotiation, that developers of alternatives should stimulate heterogeneous contributions, and that roles increase students' awareness of collaboration (Strijbos et al., 2004), this study aims to show that enhanced collaboration resulting in higher levels of knowledge construction can be expected when the role of moderator is assigned to a student and when a developer of alternatives is involved.

Method

Participants

The study involved a total of 49 students, interning at the paediatric ward of Ghent University Hospital. They were enrolled as sixth-year medical students and participated in this study during their clinical rotation. They were on average 24 years (SD = 3, range 23–43) and there were 32 females (65%) and 17 males (35%). Each student usually rotated for one month at the paediatric ward. On average, four to five student-interns per month were involved in the asynchronous discussions.

Context

At the Ghent University Hospital asynchronous discussion groups were introduced during the clinical rotation in paediatrics. All student-interns meet weekly for case-based face-to-face discussion groups, guided by a staff member. During these discussions students present patient problems to their peers, who interactively try to define the patient problem and explore the history, clinical examination, differential diagnosis, and therapeutic options. Since interference with ward-based activities and staff-schedules made the expansion of face-to-face contacts impossible, online case-based discussion groups were introduced in order to meet students' and staff's wishes for extra discussions focusing on patient management and therapeutic options. Although both collaborative approaches run in parallel, the online discussions differ from the face-to-face discussions. While the face-to-face discussions focus on the diagnostic process and start from the patients' presenting problem, the main goal for introducing the case-based asynchronous discussion groups was to enhance reflection and critical thinking on patient management. The asynchronous e-discussions focus on treatment options and informing the patients or parents. They start from a complete case description with a given diagnosis, based on real-life cases. The content of the cases stimulates students to learn collaboratively, to reflect, and to use electronic information resources. Several links to electronic resources, such as journals, Medline, and Evidence Based Medicine information databases were provided and their employment was encouraged, as McGlade et al. (2001) pointed out that students' use of and skills in ICT is more influenced by specific course demands than by undertaking a single module in medical informatics.

Due to the specific nature of discussing in a computer-supported collaborative learning (CSCL) environment and the integrated use of ICT, an introductory session was organised for each group prior to the onset of the discussions. The introduction focused on the use of ICT in general, on the available electronic information resources, and on the applications in the CSCL environment. In order to ensure that students became familiar with the online discussion approach and the technology, they were confronted with a sample case which had to be solved through online discussion. To ensure commensurable training for all research groups, all introductory information could be retrieved online.

After the sample case, each group of students (including all students interning at the paediatric ward during one month) tackled four authentic cases. Each case was dealt with asynchronously over a two-week period. Participation in the discussion groups was obligatory and formed a formal part of the curriculum. Students were evaluated by a university staff member (25% of final score). Students were required to post a minimum of four messages per case discussion. Further, they were asked to support their contributions with arguments, scientific data, and information about the sources they referred to. For each case to be discussed, the students received information about the patient, the signs and symptoms, and the diagnosis. Three learning objectives were presented to the students: determining the ensuing patient management and treatment procedure, based on the analysis of the clinical problem; adducing argumentations to support the solutions and strategies put forward while evaluating the value of information found (Hagdrup et al., 1999); and verifying one's own contributions with other students' input.

During the first three days of every new discussion period, all students had to develop a solution to the case individually. During this period, they could not read each other's messages. From day four on, all posts were made visible and students started the discussion. Some of the discussions were moderated by a senior staff member of the medicine faculty, while others were moderated by one of the students in the group. In the first two weeks, students worked simultaneously on case one and two, while case three and four where both tackled in the following two weeks. The discussion groups were designed with Web Crossing (http://webcrossing.com/). This environment allows users to receive an outline of the discussion thread and to track individual students' input.

Research design

Since the assignment of students to the specific research conditions could not be completely controlled, a quasi-experimental design was set up. Eleven groups of students, assigned to one-month clinical rotations in paediatrics, were involved in the study.

In order to study the impact of role assignment on the social construction of knowledge in this CSCL environment, different conditions were created on the basis of two variables: (1) the position of the moderator and (2) the presence of a developer of alternatives for patient management.

Concerning the first variable, the discussion groups were divided in two experimental conditions: a condition where the instructor was asked to moderate the discussions versus a condition where a student was requested to moderate the debates. In the latter condition, the assignment of the moderator role was clearly mentioned on the website of the discussion boards. A cross-over design was applied, so all students participated in both instructor-moderated and student-moderated discussions. Only one student per group was assigned the role of moderator, so not all students performed this role.

With regard to the second variable, two conditions were distinguished as well: in the first condition no one was asked to perform the role of developer of alternatives, while in the second condition one group member was explicitly asked to develop alternative treatments. By combining both variables, four different conditions were created. For each discussion information was obtained on the status of the moderator (instructor versus student), the developer of alternatives (absent versus present), and the discussion moment (first two weeks versus last two weeks of the month).

Hypotheses

This study examines the impact of role assignment on knowledge construction through social negotiation. As the role of moderator is carried out by either the instructor or a student, the differences between these two conditions are explored. Further, the study examines the impact of the allocation of a developer of alternatives for patient management to discussion groups. In addition, we want to check for an interaction effect between both experimental variables and for the effect of the point in time the discussions are organised (first two weeks versus last two weeks of the month). Finally, the levels of knowledge construction in contributions of students performing the role of moderator or developer of alternatives are examined. Building on previous research emphasising the importance attributed to structure in general (De Wever et al., 2002; Gilbert and Dabbagh, 2005; Schellens and Valcke, 2005) and more specifically to roles (Schellens et al., 2005; Aviv et al., 2003; Aviv, 2000; Strijbos et al., 2004), building on the literature of related research fields mentioned in the introduction, and taking into account that specific guidelines were provided to student moderators, the following hypotheses are tested: higher levels of knowledge construction can be observed in contributions of students in conditions with (1) a student as moderator (versus instructor-moderated discussions) and (2) a developer of alternatives; (3) an interaction effect between both variables exists: the combination of a student moderator and a developer of alternatives leads to higher levels of knowledge construction; and (4) students performing the role of moderator and developer of alternatives both contribute messages reflecting higher levels of knowledge construction.

Data set and analysis instrument

Data were gathered from March 2003 to January 2004. The data set comprises the transcripts of all messages posted by the students during the discussions. All messages in the transcripts were divided into thematical units of analysis. These message units were coded independently by two trained coders. Message units reflect specific levels of social construction of knowledge and differ in the amount of explicit comparison, contrasting, and discussion. In order to determine the level of social construction of knowledge, the interaction analysis model of Gunawardena et al. (1997) was applied. This model distinguishes different levels of knowledge construction activities: (1) sharing and comparing information, (2) identifying areas of disagreement, (3) negotiating meaning and co-construction of knowledge, (4) evaluation and modification of new schemas that result from co-construction, and (5) reaching and stating agreement and application of co-constructed knowledge. It is important to notice that, although messages at level 1 are a prerequisite for a discussion, all levels in the model are important and eventually the highest levels should be reached (Schellens and Valcke, 2005). This analysis scheme was selected on the basis of the social-constructivist theoretical background, while taking into account that it is one of the few content analysis models with an existing research base (Marra et al., 2004; Schellens and Valcke, 2005; De Wever et al., 2006).

Statistical analysis

To examine the interrater reliability, the statistical package R 1.8.1. was employed for the calculation of Krippendorff's alpha, while the descriptive results were calculated with SPSS 11.0.1. In order to take the hierarchical nesting of message units within students and students within groups into account, multilevel modelling was opted for. Multilevel models are developed to analyse data that have a hierarchical or clustered structure (Hox, 1998). To test the hypotheses, multilevel models based on a logit-link function are used. Both Predictive/Penalized Quasi-likelihood Procedure (PQL) second approximation procedures (Rasbash et al., 2004) and Markov chain Monte Carlo (MCMC) methods (Browne, 2004) were applied within MLwiN 2.01. No substantial differences between both methods were encountered. As MCMC methods are less biased (Browne et al., 2005), all reported estimates are based on MCMC methods with at least 20000 iterations. All analyses assume a 95% confidence interval (alpha(α) = 0.05).

Coding strategy and reliability

Two independent coders were trained during approximately 3 h to carry out the coding activity. First, they received an introduction to the research set-up. Next, they were informed on how to identify units of meaning and on how to assign codes to these units of analysis: they were introduced to the coding model, they discussed the theoretical basis, and explored coding examples for each level in the hierarchical interaction analysis model (Gunawardena et al., 1997).

Interrater reliability was checked. Due to the fact that thematic units were used as analysis units, calculating the interrater reliability was not easy. The problem is more specifically connected to the fact that every coder could identify her own thematic units. In case the distinguished units of different coders did not correspond, the units were broken up into parts equal to the smallest unit. If, for instance, coder A recognised two units in one message and coded the first unit as level 1 and the second as level 2; and coder B codes the whole message as level 1, we were forced to break down the message in two parts in order to analyse both codes. (Part one was coded level 1 by both raters, while part two was coded level 2 by the first rater and level 1 by the second).

All the coding was done independently with 25% of overlap (randomly selected) to calculate coding reliability. Both raters agreed upon 67% of all messages (percent agreement, PA = .67). However, the data were rearranged for analysis purposes (see results section). This resulted in a percent agreement of .74 for the categories on which the multilevel logit analyses are based. This can be considered reliable because, although no real consensus about a rule of thumb for the percent agreement statistic seems to exist, often a cut-off figure of .75 to .80 is used, while others declare .70 to be considered reliable (Rourke et al., 2001; Neuendorf, 2002).

Results

In total 885 messages were analysed (11124 lines of text) and 1813 message units were identified. 291 message units (13.4% of the messages) were posted by the instructor and are not taken into account in the multilevel analyses. In total, 1522 student message units were analysed using the interaction analysis model of Gunawardena et al. (1997). 80 student message units were not coded, mainly because they did not contain information (empty messages), or contained duplicated information (double messages). Table I gives an overview of the messages coded and shows that 69% of the messages have been coded as level 1 (sharing and comparing of information). Further, it can be noticed that messages of level 2 and 3 (exploration of dissonance and negotiation of meaning) occur regularly (approximately 10 and 15%). Messages at level 5 (agreement statements and applications of newly-constructed meaning) occur less (approximately 6%), while messages of level 4 (testing synthesis) are quite rare (approximately 1%).

Table I. Levels of knowledge construction through social negotiation based on the interaction analysis model of Gunawardena et al. (1997)

Level	Frequency	Percent
1. Sharing and comparing information	995	69.0
2. Exploration of dissonance	140	9.7
3. Negotiation of meaning	213	14.8
4. Testing synthesis	11	.8
5. Agreement statements and applications of newly-constructed meaning	83	5.8
Total	1442	100.0

Table II. Multilevel estimates for impact on knowledge construction

Parameter	Model A	Model B	Model C	Model D	Model E	OR & CI Model E
Fixed						
Intercept	−0.924	−0.950	−1.040	−1.011	−1.029	
	(0.143)	(0.113)	(0.149)	(0.145)	(0.131)	
	[−6.462]	[−8.407]	[−6.980]	[−6.966]	[−7.855]	
	{<0.001}	{<0.001}	{<0.001}	{<0.001}	{<0.001}	
Condition: Student–moderator			0.236	0.249	-0.012	OR: 0.99 CI: 0.73–1.34
			(0.150)	(0.146)	(0.157)	
			[1.573]	[1.705]	[−0.076]	
			{0.116}	{0.088}	{0.939}	
Condition: Developer alternatives			−0.689	−0.519	−0.553	OR: 0.58 CI: 0.35–0.96
			(0.273)	(0.299)	(0.259)	
			[−2.524]	[−1.736]	[−2.135]	
			{.012}	{.083}	{.033}	
Student–moderator * Developer alternatives			0.910	0.919	0.815	OR: 2.26 CI: 1.11–4.61
			(0.378)	(0.376)	(0.364)	
			[2.407]	[2.444]	[2.239]	
			{0.016}	{0.015}	{0.025}	
Period: End of month				−0.217		
				(0.158)		
				[−1.373]		
				{0.170}		
Student role: Moderator					0.945	OR: 2.57 CI: 1.79–3.69
					(0.184)	

					[5.136]	
					{<0.001}	
Student role: Developer					−0.394	OR: 0.67 CI: 0.34–1.32
alternatives					(0.343)	
					[−1.149]	
					{0.251}	
Random						
Level 3 – group						
σ^2_{v0}	0.138					
	(0.129)					
	[1.070]					
	{0.285}					
Level 2 – student						
σ^2_{u0}	0.107	0.287	0.351	0.370	0.236	
	(0.093)	(0.119)	(0.149)	(0.152)	(0.128)	
	[1.151]	[2.412]	[2.356]	[2.434]	[1.844]	
	{0.250}	{0.016}	{0.018}	{0.015}	{0.065}	
Model fit						
Deviance (MCMC)	1726.46	1731.05	1708.23	1706.18	1690.46	
p_D	23.27	25.78	30.22	31.65	28.24	
DIC	1749.73	1756.83	1738.46	1737.82	1718.69	
Reference model		A	B	C	C	

(Standard Error) [t-ratio / z-value] {*p*-value} OR = Odds Ratio; CI = 95% Confidence Interval

As a relatively large proportion of the message units was coded as level 1, a dichotomous variable for knowledge construction was created by collapsing all the higher levels (level 2–5). This variable was the basis for all multilevel logit models. 69% of the message units (993 message units) were situated in the first category (low level of knowledge construction) and 31% (444 message units) in the second category (which will be referred to as high level of knowledge construction). By rearranging the data in this way, a distinction was made between messages focusing on sharing and comparing of information on the one hand and messages that go beyond this level and focus on the exploration of dissonance, negotiation of meaning, testing synthesis, or reflecting on the knowledge construction process on the other hand. This distinction can be compared with two stages in online learning distinguished by Salmon (2000): seeking and giving information versus knowledge construction (Salmon, 2000; Greenhalgh, 2001).

The first multilevel logit model (see model A in Table II) was a three-level analysis, with message units at level 1, students at level 2, and groups at level 3. Large variation between groups is not assumed, partly because groups were composed equally and were considered equal and partly due to the cross-over design of the study (there were no groups in which all discussions were student-moderated or instructor-moderated and no groups in which all discussions had a developer of alternatives). Nevertheless, as individual learners are influenced by the social group and context to which they belong, and since the properties of this group are in turn influenced by the individuals who make up that group (Hox and Maas, 2002), the assumption of significant variance at the different hierarchical levels was checked. However, model A shows that both the between-group and the within-group between-student variance are not significantly different from zero ($\chi^2 = 1.147$, df $= 1$, $p = 0.284$ and $\chi^2 = 1.334$, df $= 1$, $p = 0.248$ respectively).

The second model is simplified and analyses message units at level 1, clustered within students at level 2 (see model B in Table II). The variance at level 2 is significantly different from zero ($\chi^2 = 5.847$, df $= 1$, $p = .016$), so further simplification to one-level analyses is unsuitable.

In the third model the predictors concerning condition are added in the fixed part of the model. The reference category comprises message units in discussions where the instructor was moderating and a developer of alternatives was absent. Two dummy variables (one for the condition with student-moderators and one for the condition with a developer of alternatives) and one interaction effect (student-moderator * developer of alternatives) were added to the model. Model C in Table II shows that the parameter for the student-moderator is not significant, whereas the parameter for the developer of alternatives points towards a significant negative impact on the level of knowledge construction reflected in the message units.

The odds of reflecting a high level of knowledge construction are about two times (OR = 0.50) lower for messages in the condition with a developer of alternatives as compared to the reference category. However, the parameter for the interaction between both conditions points towards a significant positive impact: the odds of reflecting a high level of knowledge construction are about 1.6 times (OR = 1.58) higher for messages in the student-moderated condition with a developer of alternatives as compared to the reference category.

In the fourth model (model D in Table II) the period when the discussions took place was controlled for, in order to check whether discussions during the last two weeks reflected differences in the level of knowledge construction as compared to discussions in the first two weeks. However, no significant differences were found. As parsimonious models are striven for, this variable was excluded from the subsequent analysis.

In the fifth model (model E in Table II), a variable indicating the specific role assignment was added. The results of this final model are discussed in detail. The reference category consists of message units in conditions where the instructor is moderating and where no developer of alternatives is involved. The average probability of message units reflecting a high level of knowledge construction for this reference category is 35.7%.

Concerning the different research conditions, the same effects as in model C can be noticed. The odds of reflecting a high level of knowledge construction are still significantly lower for messages in the condition with a developer of alternatives and still significantly higher for messages in the student-moderated condition with a developer of alternatives. These results are depicted in Figure 1.

Concerning the specific roles, messages from students assigned the role of moderator are about 2.57 times more likely to reflect a high level of knowledge construction. No significant differences were found for the mes-

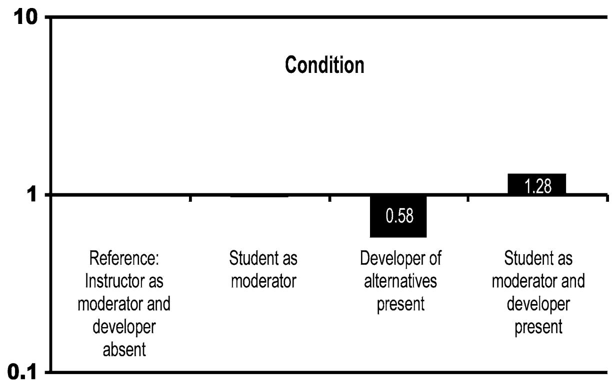

Figure 1. Odds of reflecting a high level of knowledge construction for the different conditions (based on model E in Table II).

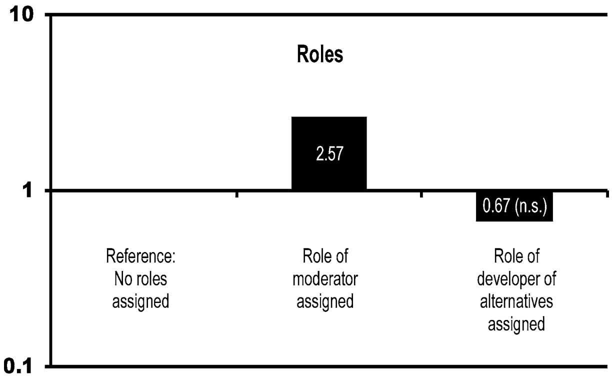

Figure 2. Odds of reflecting a high level of knowledge construction for students assigned the role of moderator or developer of alternatives (based on model E in Table II).

sages from students performing the role of developer of alternatives. Figure 2 presents the odds ratios for both roles.

Discussion

The distribution of students' contributions across the five levels of knowledge construction corresponds with findings in previous studies. The study of Gunawardena et al. (1997) reported few messages in level 4 and 5, and numerous messages in level 1. Another study of McLoughlin and Luca (2000), using the same analysis model, reported that most of the messages are situated within the first level, viz. 'sharing and comparing information'. Gunawardena et al. (2001) also state that the majority of messages in a discussion usually are situated at the first two levels. One explanation for the small number of messages situated at level 4 and 5 could be the learning culture of the students. Students are not used to test syntheses, to summarise agreements, and to apply newly constructed knowledge. Moreover, even if they would engage in this type of learning activities, they are not used to write it down explicitly in a discussion. Concluding that students do not perform any kind of metacognitive activity might be wrong, as the absence of metacognitive statements might be caused by the fact that students do not communicate explicitly about these activities. As mentioned before, messages at level 1 are a prerequisite for a discussion. However, all levels in the model are important and eventually the highest levels should be reached (Schellens and Valcke, 2005).

The differences in knowledge construction between the conditions are presented by the results of the multilevel models. Model C clearly shows that there is no significant difference between the instructor-moderated and student-moderated conditions if no developer of alternatives is involved. This might be due to the fact that except for the different tutor guidance, the learning environment in both research conditions was equivalent: Dolmans et al. (2002) argue that tutor characteristics are not only dependent from the level of expertise of the tutor, but are also influenced by differential contextual circumstances. These circumstances, such as the quality of the cases, the structure of the course, the link with students' level of prior knowledge, and the functioning of the groups are hardly different in both conditions. Both the fact that the learning environment was equivalent and the fact that sixth year students are involved might explain these findings. Although Strijbos et al. (2004) mention that roles appear to affect the perceived level of group efficiency and elicit more task content statements, recent research of Schellens et al. (2005) in the domain of educational sciences reports no significant differences between a role and a no role condition on knowledge construction.

However, when a developer of alternatives is involved, a significant difference between instructor-moderated and student-moderated discussions occurs: significantly more messages reflect a low level of knowledge construction in the instructor-moderated condition with a developer, while significantly more messages reflect a high level of knowledge construction in the student-moderated condition with a developer. In other words: the messages from students in groups where both roles are assigned to students are more likely to reflect a high level of knowledge construction, whereas the messages in groups where the instructor is moderating and a student is assigned the role of developer of alternatives are more likely to reflect a low level of knowledge construction. A possible explanation for these findings can be found in the assumption that students performing the role of developer of alternatives behave in a different way when the moderator is an instructor or a peer. Moust and Schmidt (1994) argue that when staff tutors are involved, students may feel less free to speculate about the problem-at-hand and to explain subject-matters to each other. This might especially be the case for the developer of alternatives in the present study. However, a post hoc analysis did not point to any differences in the level of knowledge construction between messages from students with the role of developer in the instructor-moderated and the student-moderated condition, which implies that all students in the former condition feel inhibited. It seems that the autonomy students experience when the instructor is not moderating the discussion stimulates them more to engage in mutual interchange and in-depth discussions, to search for dissonance or inconsistencies, and to go into negotiation. Follow-up research on this data, including additional detailed analysis of the interaction patterns, may shed a light on the ongoing communicative processes. Moreover, further research should try to reveal why this difference between instructor-moderated and student-moderated conditions only occurs when a developer of alternatives is involved.

Concerning the specific student roles, the present results pointed out that moderators are more likely to write contributions reflecting a high level of knowledge construction, whereas no differences are found for developers of alternatives. It seems that moderating the discussions coerces students to identify dissonance and harmony between the messages and to move towards the negotiation of meaning and co-construction of knowledge. The above-mentioned study of Schellens et al. (2005) has studied the impact of different roles on knowledge construction and reported a significant difference in knowledge construction for one specific role, namely summariser. These findings, combined with the results of our study, could lead to the conclusion that performing different roles might be important, as is the formulation of specific guidelines for the roles. Future research should aim to identify the factors within role assignment that are crucial for stimulating knowledge construction. However, narrow role descriptions should be avoided. Stringent roles might restrict students' autonomy, and force them to do only what is mentioned in their role description. Moreover, a too rigid script that imposes a structure alienated from the content of the discussions should be avoided (Schellens et al., 2005).

We are aware of the fact that the study has some limitations. First, the use of online discussions in an ecologically valid setting challenges the ability of the researcher to control all variables in the context. This control may have been achieved to a certain extent by the very systematic nature of the discussions. Although we used existing student groups, it is important to note that they were composed at random by the student administration.

The fact that the study is related to a specific knowledge domain is a second limitation. However, this study provides information on the use of asynchronous discussion groups and guidelines for the application of roles to structure them. Furthermore, it sheds light on the importance of the operationalisation of roles and on the underlying relations between roles. This can be further explored in future research in order to make more general statements and conclusions.

Taken into account that the present study dealt with advanced level students, a practical implication of this study does exist. By assigning the role of moderator to a student, the instructor can part with the – rather time consuming – moderation task. However, it is important to emphasise the surplus value of the instructor's presence and of a thorough description of the different roles. The instructor's role, to keep an expert eye on the content of the discussion, can not be neglected. Regarding the practical organisation, a number of characteristics, such as the formal character, the position in the curriculum, and the scripted task of the discussion groups are brought forward, which can serve as design guidelines for developing CSCL-environments.

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